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Amendments to the Specification

The entry of the amendments to the specification delineated above are respectfully requested. No new matter has been added with the foregoing amendments. The nature of the amendments to the specification are primarily grammatical. Further amendments to the specification include corrections to the specification to allow for consistent cross references between the drawings and their descriptions, such as the addition of reference numbers.

Amendments to the Claims

Applicants have amended claims 19 and 21 for grammatical reasons. The entry of the amendments to the claims is respectfully requested.

New Claims

New dependent claims 62-63 have been added to better articulate and thus provide a suitable level of protection for the present claimed invention. Entry of new claims 62-63 is respectfully requested. Claims 62-63 read on Group I of the present invention. Support for the new claims can be found in, for example, pages 15 through 21 of the present application.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 925-472-5000.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the specification:

Paragraph beginning at page 4, line 10, has been amended as follows:

Figure 1 illustrates a vacuum cluster tool 10 having multiple single substrate processing chambers 12 mounted on a centralized vacuum chamber, called a transfer chamber 18, for transferring substrates from a substrate cassette located in one or more load lock chambers 20, to one or more process chambers 12. This particular tool is shown to accommodate up to four (4) single substrate processing chambers 12 positioned radially about the transfer chamber. A cluster tool similar to that shown in Figure 1 is available from Applied Materials, Inc. of Santa Clara, California. The transfer of the substrates between the process chambers 12 is typically managed by a substrate handling module 16 located in a central transfer chamber [12]1<u>8</u>. After the substrates are processed, they are moved back through the load lock chamber 20 and into substrate cassettes where the 20 substrates can be moved to the next system for additional processing. Various processes, such as physical vapor deposition (PVD), chemical vapor deposition (CVD), etch, can be performed in the process chambers 12.

Paragraph beginning at page 5, line 22, has been amended as follows:

The apparatus of the invention may further comprise one or more substrate cooling stations disposed in the loadlock chamber connected to the transfer chamber. The capping module preferably has a substrate handling member with at least one substrate handling blade and further includes a substrate indexing device for indexing multiple substrates and a multi-slot preheating module for preheating substrates prior <u>to</u> deposition of the capping layer. Each PECVD chamber preferably has two processing regions, each processing region having a heated pedestal, a gas distribution assembly, vacuum pumping assembly, and independent RF power and temperature controls to provide a uniform plasma density 30 over a substrate surface in each processing region, wherein each processing region is in communication with a remote plasma system and the transfer chamber.

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Paragraph beginning at page 6, line 26, has been amended as follows:

In accordance with another aspect of the invention, the invention provides a process for depositing low K dielectric films having a mesoporous film structure. The low K dielectric films are deposited by curing a sol gel precursor deposited on a substrate to form a oxide film, preferably having interconnecting pores of uniform diameter, most preferably in a cubic phase structure, and then heating the oxide film in a non-reactive atmosphere at a temperature of about 200°C to about 450°C, preferably annealing the oxide film at about 400°C to about 450°C, or exposing the [firm] <u>film</u> to an oxidizing atmosphere containing a reactive oxygen species at a temperature between about 200°C and about 400°C, to form a mesoporous oxide film. The mesoporous oxide film will have a porosity of at least 50% and a dielectric constant between about 1.6 and about 2.2. The mesoporous oxide film may be used as a inter-metallayer for fabricating a dual damascene structure. A preferred mesoporous oxide film is produced by spin-on deposition of a sol gel precursor containing TEOS, water, and a surfactant in a ethanol solvent on a substrate, curing the sol gel precursor to form a film having interconnecting pores of uniform diameter, and then exposing the film to an ozone plasma.

Paragraph beginning at page 7, line 26, has been amended as follows:

Figure 3A is a top schematic planar view of one embodiment of a capping module <u>and high pressure deposition module</u> of the present invention;

Paragraph beginning at page 7, line 28, has been amended as follows:

Figure 3B is a top schematic view of one embodiment of a capping module <u>and high pressure deposition module</u> of the present invention;

Paragraph beginning at page 8, line 27, has been amended as follows:

The present invention provides a process and apparatus for depositing intermetal layers, such as low dielectric constant (low k) films, and capping layers on a substrate at both vacuum, *i.e.*, less than about 100 Torr, and atmosphere, or high pressure, conditions, *i.e.*, greater than about 300 Torr. In one aspect of the invention, the apparatus is a near vacuum pressure capping layer module capable of being mounted on processing platforms operating at atmospheric or high pressures, which processing platforms may further deposit low k dielectric layers. The capping layer module has a cassette to cassette near vacuum processing system which processes multiple substrates having a low k dielectric layer that is deposited in the attached platform. The capping

layer module is preferably a staged vacuum system which includes one or more transfer chambers each housing a substrate handler, one or more loadlock chambers, one or more multi-slot substrate preheating modules in communication with the one or more transfer chambers and which optionally may be disposed in the one or more loadlock chambers, and one or more plasma enhanced chemical vapor deposition chambers in communication with the one or more transfer chambers. [Isolatable means that the processing regions have a confined plasma zone separate from the adjacent region which is selectively communicable with the adjacent region via an exhaust system.]

Paragraph beginning at page 9, line 13, has been amended as follows:

The processing regions within each PECVD chamber also preferably include separate gas distribution assemblies and RF power sources to provide a uniform plasma density over a substrate surface in each processing region. The PECVD chambers are configured to allow multiple, isolated processes to be performed concurrently in at least two regions so that at least two substrates can be processed simultaneously in separate processing regions with a high degree of process control provided by shared gas sources, shared exhaust systems, separate gas distribution assemblies, separate RF power sources, and separate temperature control systems. For ease of description, the terms processing regions <u>or</u> a chamber may be used to designate the zone in which plasma processing is carried out<u>. Isolated processes being carried out in isolatable regions means that the processing regions have a confined plasma zone separate from the adjacent region which is selectively communicable with the adjacent region via an exhaust system.</u>

Paragraph beginning at page 10, line 16, has been amended as follows:

In accordance with one aspect of the invention, the invention provides for [an] <u>a</u> process for depositing [an] <u>a</u> mesoporous oxide layer having a low dielectric constant and a high oxide content. The mesoporous oxide layer comprises a silica material and can be capped in the capping module with other dielectric materials or with an etch stop layer, *e.g.* for fabricating a dual damascene structure. The low K dielectric layers can be deposited by curing a sol gel precursor to form a oxide film having interconnecting pores of uniform diameter, preferably in a cubic phase structure then exposing the film to an oxidizing atmosphere containing a reactive oxygen species at a temperature between about 200°C and about 400°C, to remove the surfactant and form a mesoporous oxide film. The mesoporous oxide film will have a porosity of al least 50% and a dielectric constant between about 1.6 and about 2.2. The mesoporous film may also be used as [a] <u>an</u> inter-metal

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dielectric layer. A preferred mesoporous oxide film is produced by spin-on deposition of a sol gel precursor containing tetraethylorthosililate (TEOS), water, and a surfactant in a ethanol solvent on a substrate, curing the sol gel precursor to form interconnecting pores of uniform diameter, preferably in a cubic phase film, and then removing the surfactant by an oxidizing atmosphere.

Paragraph beginning at page 11, line 1, has been amended as follows:

Figures 2A and 3A illustrate one embodiment of a capping layer module 120 of the invention schematically. The capping module 120 is a near vacuum pressure processing module for deposition of films, particularly capping films deposited by plasma enhanced chemical vapor deposition (PECVD). Near vacuum pressures are defined herein as pressures of about 100 Torr and below, and preferably the pressure of the capping module are the similar to the operating pressure of the PECVD chamber of about 0.5 Torr to about 10 Torr. The module 120 is a self-contained system having the necessary processing utilities supported on a main frame structure [201] which can be easily installed and which provides a quick start up for operation. The module 120 generally includes four regions, namely, a factory interface 122, wherein substrates are introduced into the module 120, one or more transfer chambers 126 each housing a substrate handler 127, with the substrate handler 127 preferably in communication with a dual stack cooling/pre-heat loadlock chamber 124 disposed within the factory interface 122, one or more, but preferably two tandem or twin process chambers 130 mounted to the and in communication with the transfer chamber 126, and a back end 140 which houses the support utilities needed for operation of the module 120, such as a gas panel 134, power distribution panel 136, and the computer control rack 138 as shown in Figures 2B and 3B. The system can be adapted to accommodate various processes and supporting chamber hardware such as plasma enhanced chemical vapor deposition (PECVD). The embodiment described below will be directed to a system employing a PECVD process, [such as] <u>and</u> a mesoporous oxide dielectric deposition process. However, it is to be understood that these other processes are contemplated by the present invention.

Paragraph beginning at page 12, line 9, has been amended as follows:

Figure 2A shows a top schematic view of one embodiment of the processing module 120 of the present invention. The processing module 120 encompasses transfer chamber 126 inside a chamber sidewall 133. The transfer chambers include sidewalls 133 and bottom [135] and are preferably machined or otherwise fabricated from one piece of material, such as aluminum. A lid

(not shown) for transfer chamber 126 is supported on the sidewalls 133 during operation to form a vacuum enclosure. The sidewall 133 of transfer chamber 126 supports processing chambers 130 and provides an attachment for a factory interface 122 which may contain one or more cooling/pre-heat loadlock chambers 124 (shown in figure 4 below) which may provide access via slit valve 121 to other transfer chambers or act as a substrate insertion point for processing in the processing chambers 130. The sidewall 133 for transfer chamber 126 defines passage 128 and 132 on each side through which access to the other chambers on the system is provided. The passages 128 and 132 disposed through the sidewalls 133 can be opened and closed using two individual slit valves or a tandem slit valve assembly. The passages 128 provide access <u>to</u> the factory interface or substrate staging area 122 wherein substrates may be introduced into the transfer chambers 126. The passages 132 mate with the substrate passages 610 in process regions 618, 620 (shown in Figure 9) to allow entry of substrates into the processing regions 618, 620 in processing chamber 130 for positioning on the substrate heater pedestal 628.

Paragraph beginning at page 13, line 8, has been amended as follows:

Figure 2B shows a top schematic view of another embodiment of the processing module 120 of the present invention. The second embodiment of the processing module 120 comprises two transfer chambers 126A, 126B inside a chamber sidewall 133. The transfer chambers 126A, 126B are isolated from one another and are in communication with both the factory interface 122 which preferably only contains one or more cooling chambers, and one or more pre-heat loadlock chambers 124 disposed perpendicular to the factory interface [112] <u>122</u>, and one or more processing chambers 130 or one or more processing regions 618, 620. The sidewall 133 for transfer chambers 126A, 126B defines passages 128 and 132 on each side through which access to the other chambers on the system is provided.

Paragraph beginning at page 14, line 9, has been amended as follows:

Once the substrate is deposited, the transfer chamber substrate handlers 127 withdraw from the processing chamber 130 and the slit valves 132 are closed. The substrate having already been deposited with a dielectric layer in the high pressure deposition module 101 is then deposited with a capping layer by PECVD in the processing chamber 130. After processing is finished, the slit valves 132 are opened and the transfer chamber substrate [handler127 remove] <u>handler 127 removes</u> the substrates from the processing regions 618, 620 and [deposit] <u>deposits</u> the substrates in the

cooling compartment 242 of the dual stack cooling/pre-heat loadlock chamber 124. After depositing a substrate in the preheating modules 124, the substrate handler retrieves the next pair of substrates from dual stack cooling/pre-heat loadlock chamber 124 <u>as</u> indicated in the indexing sequence. This substrate is then transferred, processed, and retrieved by the transfer chamber substrate handler 127 as the preceding substrate. This process continues until all of the substrates of the pre-heating compartment 244 are processed in the PECVD processing chamber 130 and deposited in the cooling compartment 244. After the last substrate is processed the slit valves 132 to the processing chamber 130 are closed.

Paragraph beginning at page 14, line 24, has been amended as follows:

The transfer chamber 126 is then vented to atmosphere pressure using an inert gas, such as argon, and the front vacuum doors 128 are opened. The transfer chamber venting may optionally begin as soon as the slit valves 132 have closed after the last pair of substrates have been processed. This allows the transfer chamber 126 to be vented as the last set of substrates are being returned to the dual stack cooling/pre-heat loadlock chamber 124 which reduces processing time in the capping module 120. Once venting is complete, the transfer chamber substrate handler 112 of the high pressure deposition module 101 [retrieve] <u>retrieves</u> the substrates from the dual stack cooling/pre-heat loadlock chamber and simultaneously [unload] <u>unloads</u> all of the processed substrates to the substrate cassettes 104 located in the front end staging area 102 of the high pressure deposition module 101. After the last pair of substrates in each batch have been processed and removed from the processing chamber 130 and the slit valves 132 have been closed, the process chamber cleaning process can occur preparing the processing chamber for the next batch of substrates. This enables the cleaning process to be ongoing in the background while the transfer chamber 126 is being vented and the substrates are being exchanged.

Paragraph beginning at page 16, line 9, has been amended as follows:

The front end staging area 102 of the high pressure deposition module 101 of tile processing system 100 typically has one or more substrate cassettes 106 mounted in a horizontally spaced relationship from one another on a staging platform 102 which is coupled to the transfer chamber 108 of the high pressure deposition module 101. The substrate cassettes 106 are adapted to support a plurality of substrates mounted in a spaced vertical arrangement. The substrate cassettes 106 preferably includes two or more cassette plates (not shown) or other substrate supports disposed

in a spaced vertical relationship to support the substrates disposed therein in a stacked vertical arrangement. A substrate rest 103 may be disposed between the dual stack cooling stations 110 in cooling station 111 and the loadlocks [106] 122 to provide a cooling rest for substrates during substrate exchange between the cooling station 111 and the loadlocks [106] 122. Alternatively, the substrate rest 103 may provide a preheating station for substrates passing into the module 101 for processing.

Paragraph beginning at page 16, line 22, has been amended as follows:

A pair of substrate handlers, or staging substrate handlers 104, are disposed in the front end staging area 102. The staging substrate handlers 104 are adapted to load a substrate into and remove a substrate from the high pressure deposition module 101 or the substrate cassettes 106 of the high pressure deposition module 101, wherein the staging substrate handler 104 is preferably positioned between the substrate cassettes 106 and the dual stack cooling stations [110of] 110 of the high pressure deposition module 101. Preferably, the staging substrate handler 104 includes a substrate indexing system to index the substrates in each substrate cassette 106 in preparation for loading the substrates into high pressure deposition module 101. One substrate handler with a substrate mapping system used advantageously in the present system is available from Equippe Technologies, located in Sunnyvale, California, as Model Nos. ATM 105 or 107. The substrate mapping sensor verifies the number of substrates and orientation of the substrates in the cassette 106 before transferring the substrates into the transfer chamber 108 of the high pressure deposition module 101 for dielectric layer deposition.

Paragraph beginning at page 18, line 15, has been amended as follows:

Referring back to Figures [2 and 3] 2A, 2B, 3A, and 3B, the factory interface or substrate staging area 122 is an atmosphere pressure apparatus which allows quick transfer from the substrate staging area to chambers, such as the high pressure deposition module 101 prior to vacuum pumping, that typically operate at or near atmosphere pressures. Figure 3A shows the front end staging area [102] 122 of the module 101 which preferably includes a dual stack cooling/pre-heat loadlock chamber 124 having one or more substrate cassettes mounted within the dual stack cooling/pre-heat loadlock chamber 124 for processing. The substrate cassettes are designed to support a plurality of substrates in a spaced vertical relation, wherein substrate handling members 112, 127 may deposit and retrieve the substrates from opposites side of the substrate cassettes. In

the alternative embodiment shown in Figure [2A] 2B, the loadlock chamber 124 also functions as a cooling station for substrate transport between modules 101 and 120, and the pre-heating performed in a separate chamber.

Paragraph beginning at page 19, line 13, has been amended as follows:

Figure 4 shows a cut-away perspective view of a cooling/pre-heat loadlock chamber 124 of the present invention. The cooling/pre-heat loadloack chamber 124 includes chamber walls 202, a bottom 204, and a lid 206. The chamber 124 includes two separate environments or compartments 242, 244 and a transfer region 246. Compartments 242, 244 include a substrate cassette in each compartment 242, 244 to support the substrates therein. Each compartment 242, 244 includes a support platform 248 and a top platform 250 to define the bottom and top of the compartments 242, 244. A support wall 252 may be disposed vertically within the compartments 242, 244 to support platforms 248, 250 in a spaced relationship. Transfer region 246 includes one or more passages 121, 128 for providing access from the cooling/pre-heat loadloack chamber 124 into the transfer chambers 108, 126. Passages 121, 128 are preferably opened and closed using slit valves and slit valve actuators.

Paragraph beginning at page 19, line 25, has been amended as follows:

Compartment 242 provides a cooling station for substrates following processing in the processing chambers of transfer chamber 108 or in the capping module 120. In the alternative embodiment shown in Figure 2A, [both] compartments [242, 244] 124 may provide cooling stations for substrates following processing in the processing chambers of transfer chamber 108 or in the capping module 120.

Paragraph beginning at page 19, line 30, has been amended as follows:

Compartment 244 is selectively heated with respect to compartment 242, thereby acting as a pre-heat module prior to processing of the substrates in the processing chambers 130 of the capping module 120. The heating compartment 244 preferably has a heating element, such as a heating lamp, fluid heat exchanger, or a resistive heating element, to heat substrates individually therein, or alternatively, may have a heating element for heating all substrates within the compartment 244 concurrently. In another embodiment of the loadlock [124] 122, the curing modules 116 may be mounted in the pre-heating compartment 244, thereby providing curing of the

deposited film or pre-heating of the substrate prior to processing in module 120 while efficiently conserving space.

Paragraph beginning at page 23, line 7, has been amended as follows:

Figure 6 shows the substrate handler arms and blade assembly of Figure 5 in an extended position. This extension is accomplished by the simultaneous and equal rotation of magnet clamp 526 in a clock-wise direction and magnet clamp 524 in a counter-clockwise rotation. The individual blades 520, 522 of the substrate blade assembly 540 are sufficiently long to extend through the passages 132 and center the substrates 502 over the pedestals 628 (See Figure [8] 9). Once the substrates 502 have been lifted from the blades by a pair of lift pin assemblies, then the blades are retracted and the passages 132 are closed by a slit valve and actuator as described above.

Paragraph beginning at page 23, line 17, has been amended as follows:

Figure 7 is a cross sectional view of an exemplary substrate stripping chamber of the invention. More particularly, Figure 7 is a rapid thermal anneal chamber that is capable of both a non-reactive gas anneal and an oxidizing gas strip of a deposited film. The substrate stripping chamber or rapid thermal anneal (RTA) chamber 118 is preferably connected to the transfer chamber 108. The high pressure deposition module 101, as shown in Figures [2 and 3] 3A and 3B, preferably comprises two RTA chambers 118 preferably disposed on opposing sides of the transfer chamber 108 from the capping module 120, with the substrates [are] transferred into and out of the RTA chamber 118 by the substrate handler 112.

Paragraph beginning at page 24, line 5, has been amended as follows:

The RTA chamber 118 generally comprises an enclosure 902, a heater plate 904, a heater 907 and a plurality of substrate support pins 906. The enclosure 902 includes a base 908, a sidewall 910 and a top 912. Preferably, a cold plate 913 is disposed below the top 912 of the enclosure. Alternatively, the cold plate is integrally formed as part of the top 912 of the enclosure. Preferably, a reflector insulator dish 914 is disposed inside the enclosure 902 on the base 908. The reflector insulator dish 914 is typically made from a material such as quartz, alumina, or other material that can withstand high temperatures *(i.e.,* greater than about 500°C), and act as a thermal

insulator between the heater 907 and the enclosure 902. The dish 914 may also be coated with a reflective material, such as gold, to direct heat back to the heater plate [906] <u>904</u>.

Paragraph beginning at page 24, line 15, has been amended as follows:

The heater plate 904 preferably has a large mass compared to the substrate being processed in the system and is preferably fabricated from a material such as silicon carbide, quartz, or other materials that do not react with any ambient gases in the RTA chamber 118 or with the substrate material. The heater 907 typically comprises a resistive heating element or a conductive/radiant heat source and is disposed between the heated plate [906] <u>904</u> and the reflector insulator dish 914. The heater 907 is connected to a power source 916 which supplies the energy needed to heat the heater 907. Preferably, a thermocouple 920 is disposed in a conduit 922, disposed through the base 908 and dish 914, and extends into the heater plate 904. The thermocouple 920 is connected to a controller 921 and supplies temperature measurements to the controller 921. The controller 921 then increases or decreases the heat supplied by the heater 907 according to the temperature measurements and the desired anneal temperature.

Paragraph beginning at page 25, line 2, has been amended as follows:

The RTA chamber 118 includes a slit valve [922] <u>923</u> disposed on the sidewall 910 of the enclosure 902 for facilitating transfers of substrates into and out of the RTA chamber 118. The slit valve [922] <u>923</u> selectively seals an opening 924 on the sidewall 910 of the enclosure that communicates with the transfer chamber 108. The substrate handler 112 transfers substrates into and out of the RTA chamber through the opening 924.

Paragraph beginning at page 25, line 17, has been amended as follows:

To transfer a substrate into the RTA chamber 118, the slit valve [922] <u>923</u> is opened, and the loading station transfer substrate handler [228] <u>112</u> extends its substrate handler blade having a substrate positioned thereon through the opening 924 into the RTA chamber. The substrate handler blade of the loading station transfer substrate handler [228] <u>112</u> positions the substrate in the RTA chamber above the heater plate 904, and the substrate support pins 906 are extended upwards to lift the substrate above the substrate handler blade. The substrate handler blade then retracts out of the RTA chamber, and the slit valve [922] <u>923</u> closes the opening. The substrate support pins 906 are then retracted to lower the substrate to a desired distance from the heater plate 904. Optionally,

the substrate support pins 906 may retract fully to place the substrate in direct contact with the heater plate.

Paragraph beginning at page 27, line 6, has been amended as follows:

After the stripping process is completed, the substrate support pins 906 lift the substrate to a position for transfer out of the RTA chamber 118. The slit valve [922] 923 opens, and the substrate handler 112 of the transfer chamber 108 is extended into the RTA chamber and positioned below the substrate. The substrate support pins 906 retract to lower the substrate onto the substrate handler blade, and the substrate handler blade then retracts out of the RTA chamber.

Paragraph beginning at page 29, line 7, has been amended as follows:

The chamber body 602 defines a plurality of vertical gas passages for each reactant gas and cleaning gas suitable for the selected process to be delivered in the chamber through the gas distribution system. Gas inlet connections 641 are disposed at the bottom of the chamber [126] 616 to connect the gas passages formed in the chamber wall to the gas inlet lines 639. An o-ring is provided around each gas passage formed through the chamber wall on the upper surface of the chamber wall to provide sealing connection with the lid as shown in Figure 11. The lid includes matching passages to deliver the gas from the lower portion of the chamber wall into a gas inlet manifold 670 positioned on top of the chamber lid as shown in Figure 10. The reactant gases are delivered through a voltage gradient feed-through 672 and into a gas outlet manifold 674 which is connected to a gas distribution assembly.

Paragraph beginning at page 31, line 22, has been amended as follows:

The heater pedestal 628 is raised and lowered by moving the transfer housing up or down to a process, clean, lift and release position by a drive system 603 having linear electric actuators (not shown). The transfer housing is connected to the actuator on one side and a linear slide (not shown) on the other through a carriage plate (not shown). The connection between the actuator and the carriage is made via a flexible (ball and socket) joint (not shown) to allow for any misalignment. The linear slide and carriage plate are biased against one another to prevent rotation and bending thereof. A bellows surrounds the stem 626 of the heater pedestal 628 and connects to the chamber bottom 616 on one end and to the transfer housing on the other end. A seal ring (not shown) is provided in a groove 630 in the stem 626 to seal the outer surface of the lower end of the

stem in the engage lower spherical portions 661 of the lift pins 651 and a drive member which positions the pin support 655 to selectively engage the lift pins 651 depending on the position of the heater pedestal 628 within the processing region. The pin support 655, preferably made from ceramic, extends around the stem 626 below the heater pedestal 628 to selectively engage the lower spherical portions of the support pins.

Paragraph beginning at page 33, line 13, has been amended as follows:

Referring to Figures [2 and 3] 2A, 2B, 3A, and 3B, on the outside of the chamber on the back end of the system, there is a gas supply panel [219] 134 containing the gases that are to be used during deposition and cleaning. The particular gases that are used depend upon the materials to be deposited onto the substrate or removed from the chamber 130. The process gases flow through an inlet port into the gas manifold and then into the chamber through a shower head type gas distribution assembly. An electronically operated valve and flow control mechanism control the flow of gases from the gas supply into the chamber.

Paragraph beginning at page 33, line 20, has been amended as follows:

In one embodiment of the invention the precursor gases are delivered from the gas box [219] 134 to the chamber 130 where the gas line tees into two separate gas lines which feed gases through the chamber body as described above. Depending on the process, any number of gases can be delivered in this manner and can be mixed either before they are delivered to the bottom of the chamber or once they have entered the gas distribution plate.

Paragraph beginning at page 33, line 27, has been amended as follows:

Referring to Figures [2 and 3] 2A, 2B, 3A, and 3B, an advanced compact RF ("CRF") power delivery system 136 is used for each processing region 618, 620 with one system connected to each gas distribution system [219] 134. A 13.56 MHz RF generator, Genesis Series, manufactured by ENI, is mounted on the back end of the system for each chamber. This high frequency generator is designed for use with a fixed match and regulates the power delivered to the load, eliminating the concern about forward and reflected power. To interface a high frequency RF generator and a low frequency RF generator to a process chamber, a low pass filter is designed into the fixed match enclosure.

Paragraph beginning at page 34, line 12, has been amended as follows:

The system controller 138 shown in Figures [2 and 3] 2A, 2B, 3A, and 3B operates under the control of a computer program stored on the hard disk drive of a computer. The computer program dictates the process sequencing and timing, mixture of gases, chamber pressures, RF power levels, susceptor positioning, slit valve opening and closing, substrate heating and other parameters of a particular process. The interface between a user and the system controller is preferably via a CRT monitor and lightpen (not shown). In a preferred embodiment two monitors are used, one monitor mounted in the clean room wall for the operators and the other monitor behind the wall for the service technicians. Both monitors simultaneously display the same information but only one lightpen is enabled. The lightpen detects light emitted by the CRT display with a light sensor in the tip of the pen. To select a particular screen or function, the operator touches a designated area of the display screen and pushes the button on the pen. The display screen generally confirms communication between the lightpen and the touched area by changing its appearance, i.e. highlight or color, or displaying a new menu or screen.

Paragraph beginning at page 39, line 21, has been amended as follows:

While the system of the present invention was described above with reference to a plasma enhanced CVD application, it is to be understood that the invention also includes the use of high density (HDP) CVD and PVD chambers as well as etch chambers. For example, the system of the present invention can be adapted to include tandem HDP CVD chambers for plasma processing. In one alternative embodiment, the gas distribution/lid assembly could be replaced with a dielectric dome having an inductive coil disposed about the dome and an RF power supply connected to the coil to enable inductive coupling of a high density plasma within the chamber. Similarly, tandem PVD chambers could be configured with a target assembly disposed thereon for a deposition material source. DC power supplies could be connected to the target assemblies to provide sputtering power thereto.

Paragraph beginning at page 40, line 18, has been amended as follows:

The process begins in the high pressure deposition module by the formation of a sol gel precursor. Sol gel precursors are typically formed by the mixture of a silicon/oxygen compound, water, and a surfactant in an organic solvent. Any conventional method known in the art may be used to form a sol gel precursor, but [a] an exemplary sol gel precursor of the invention may be

formed by a mixture of tetraethylorthosilicate (TEOS), ethanol, water, and a surfactant. An optional acid or base catalyst may be further used in the formation of the sol gel precursor.

Paragraph beginning at page 41, line 2, has been amended as follows:

The silicon/oxygen compound of the sol gel precursor are those conventionally used in the deposition of silicon containing layers in semiconductor manufacturing, wherein silica sols are most preferably used. The silicon/oxygen precursor compound tetraethoxysilane (TEOS), phenyltriethyloxy silane, methyltriethoxy silane are preferably [used,[however] <u>used, however</u>, any commercially available or conventionally used sol gel silicon/oxygen compound, such as tetramethoxysilane (TMOS) may be used with the invention.

Paragraph beginning at page 41, line 8, has been amended as follows:

Surfactants are used in sol gel precursors to ensure effective dispersion of the silicon/oxygen compounds in the solution for even film content deposition on the substrate. Surfactants may be anionic, cationic, or non-ionic. Surfactants use bonding groups that are hydrophilic to ensure a thorough dispersion in a solvent containing water.[,] Non-ionic surfactants have chemical bonding groups that are uncharged or neutral hydrophilic groups while anionic and cationic surfactants have bonding groups respectfully charged negatively and positively. For the formation of the interconnecting pores of uniform diameter, preferably in a cubic phase structure of the invention, a non-ionic surfactant is used and is preferably selected from the group of primary amines, polyoxyethylene oxides-propylene oxide-polyethylene oxide triblock copolymers, octaethylene glycol monodecyl ether, octaethylene glycol monohexadecyl ether, and combinations thereof.

Paragraph beginning at page 42, line 4, has been amended as follows:

The deposited film is exposed to an oxidizing atmosphere at an elevated temperature. The temperature of the oxidizing atmosphere is preferably in the range of about 200°C to about 400°C. The oxidizing environment preferably comprises oxygen, ozone, or an oxygen plasma to form a reactive oxygen species, wherein most preferably, a ozone plasma is formed in the chamber. The plasma is performed at a pressure of between about 0.5 Torr and about 10 Torr. The oxygen species bombard the film and react with the surfactant and any remaining moisture and solvent, thereby removing those agents from the film. The ion species are highly reactive and only require a

short exposure of about 0.5 minutes to about 5 minutes for removal of the surfactant. As the surfactants are removed from the film, pores are formed as the silicon/oxygen component of the assemblies retain the shape of the oxide film, preferably a cubic phase structure, and harden to form a mesoporous film. The pores [are] usually have an interconnected structure, but many have terminal branches or may form amorphous layers. The selective formation of the mesoporous films result in a highly porous film of greater than 50% air with an exhibited dielectric constant of less than 2.5, preferably between about 2.2 and 1.6.

Paragraph beginning at page 43, line 21, has been amended as follows:

A capping layer deposited on the mesoporous oxide layer may be any material which provides a barrier from diffusion of such materials as moisture, which serves as an etch stop, or which serves as a hard mask. Preferably, the capping layer is [an] a low dielectric film deposited by a plasma enhanced chemical vapor deposition (PECVD) chamber at chamber pressures of about 0.5 Torr to about 10 Torr. Examples of suitable materials are silicon dioxide, silicon nitride, silicon oxynitride, and amorphous silicon carbide. An exemplary material to use as a liner layer is an amorphous silicon carbide layer, BLOk™, which is described in U.S. Patent Application Serial [No,] No. 09/165,248, entitled, "A Silicon Carbide Deposition For Use As A Barrier Layer And An Etch Stop", Filed on October 1, 1998, and incorporated herein.

Paragraph beginning at page 45, line 3, has been amended as follows:

After low k etch stop 410 has been etched to pattern the contacts/vias and the photo resist has been removed as shown in Fig. 15B, a second mesoporous oxide dielectric layer 414 is deposited over etch stop 410 to a thickness of about 5,000 to about 10,000A as shown in Fig. [12C] 15C. A second etch stop 416, preferably of BLOk™ deposited in a capping module as shown in Fig. 15C, and a photo resist layer 418 are deposited on the second mesoporous oxide dielectric layer 414, prior to being patterned to define interconnect lines 417, preferably using conventional photolithography processes, such as trench lithography, as shown in Fig. 15D. The interconnects and contacts/vias are then etched using reactive ion etching or other anisotropic etching techniques to define the metallization structure *(i.e.,* the interconnect and contact/via) as shown in Figure 15E. Any photo resist to pattern the second etch stop 416 or the second dielectric layer 414 is removed using an oxygen strip, inert anneal, or other suitable process. The substrate etch stop 406 is similarly

stripped to provide for contact between the patterned lines 404 and any subsequent material depositions as shown in Fig. 15F.

In the claims:

Claims 23-61 have been cancelled.

Claims 19 and 21 have been amended as follows:

19. (Amended) The apparatus of claim 12, further comprising a remote plasma system having a RF generator connected to each processing region.[.]

21. (Amended) The apparatus of claim 20, wherein the oxidation chamber [and] is connected to a remote plasma system having a RF generator or a microwave generator.

The following claims have been added:

62. The apparatus of claim 9 wherein the isolated processing region of each of said processing chambers and an interior region of said high pressure deposition module are isolatable from an exterior environment in which said apparatus is situated.

63. The apparatus of claim 12 wherein the isolated processing region of each of said processing chambers and an interior region of said high pressure deposition module are isolatable from an exterior environment in which said apparatus is situated.

Appendix

Pending Claims in Group I

1. An apparatus for processing substrates, comprising:

(a) one or more transfer chambers;

(b) a substrate handling member disposed in each of the one or more transfer chambers;

(c) one or more processing chambers, each processing chamber defining at least one isolated processing region therein, wherein each processing region is connected to the one or more transfer chambers;

(d) one or more loadlock chambers in communication with the one or more transfer chambers; and

(e) one or more multi-slot substrate pre-heating modules in communication with the one or more transfer chambers.

2. The apparatus of claim 1, further comprising one or more multi-slot cooling stations disposed within the loadlock chamber.

3. The apparatus of claim 1, further comprising a vacuum pump in fluid communication with the loadlock chamber.

4. The apparatus of claim 1, further comprising a vacuum pump in fluid communication with each processing region in the one or more processing chambers.

5. The apparatus of claim 1, wherein each processing chamber has two isolated processing regions.

6. The apparatus of claim 1, wherein each processing region includes a gas distribution assembly disposed therein and each gas distribution assembly shares process gases from one or more gas sources.

7. The apparatus of claim 1, further comprising a remote plasma system having an RF generator connected to each processing region.

8. The apparatus of claim 1, wherein a remote plasma system is in fluid communication with each processing region.

9. The apparatus of claim 2, further comprising a high pressure deposition module connected to the one or more load lock chambers.

10. The apparatus of claim 9, wherein the high pressure deposition module is a spin-on dielectric module comprising one or more substrate stripping chambers.

11. The apparatus of claim 1, wherein the one or more multi-slot pre-heating modules are disposed within the loadlock chamber.

12. An apparatus for processing substrates, comprising:

(a) a high pressure deposition module;

(b) a first transfer chamber in communication with the high pressure deposition module;

(c) a loadlock chamber in communication with the first transfer chamber;

(d) a second transfer chamber in communication with the loadlock chamber;

(e) a multi-slot substrate pre-heating module in communication with the first transfer chamber;

(f) a substrate handling member disposed in the second transfer chamber; and

(g) one or more processing chambers, each processing chamber defining at least one isolated processing region therein, wherein each processing region is connected to the second transfer chamber.

13. The apparatus of claim 12, wherein the high pressure deposition module comprises:

(a) one or more substrate spinner chambers;

(b) one or more substrate curing chambers;

(c) one or more substrate stripping chambers;

(d) one or more silylation deposition chambers; and

(e) a second substrate handling member disposed in the high pressure deposition module.

14. The apparatus of claim 12, further comprising one or more multi-slot cooling stations disposed within each of the one or more loadlock chambers.

15. The apparatus of claim 12, further comprising a vacuum pump in fluid communication with the one or more loadlock chambers.

16. The apparatus of claim 12, further comprising a vacuum pump in fluid communication with each processing region.

17. The apparatus of claim 12, wherein each processing chamber has two isolated processing regions.

18. The apparatus of claim 12, wherein each processing region includes a gas distribution assembly disposed therein and each gas distribution assembly shares process gases from one or more gas sources.

19. The apparatus of claim 12, further comprising a remote plasma system having a RF generator connected to each processing region.

20. The apparatus of claim 19, wherein each substrate stripping chamber is an oxidation chamber.

21. The apparatus of claim 20, wherein the oxidation chamber is connected to a remote plasma system having a RF generator or a microwave generator.

22. The apparatus of claim 12, wherein the multi-slot pre-heating module is disposed within the loadlock chamber.

62. The apparatus of claim 9 wherein the isolated processing region of each of said processing chambers and an interior region of said high pressure deposition module are isolatable from an exterior environment in which said apparatus is situated.

63. The apparatus of claim 12 wherein the isolated processing region of each of said processing chambers and an interior region of said high pressure deposition module are isolatable from an exterior environment in which said apparatus is situated.